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Soil Survey
of
The Fort Collins Area, Colorado

By

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and
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Bureau of Chemistry and Soils
In cooperation with the
Colorado Agricultural Experiment Station

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By A. T. SWEET, U. S. Department of Agriculture, in Charge, and J. N. SPENCER, Colorado Agricultural Experiment Station

AREA SURVEYED

The Fort Collins area is in the north-central part of Colorado, its southern limits being about 36 miles north of Denver. (Fig. 1.) The area extends 34 miles from north to south, and its greatest east and west dimension is 16 miles. It includes 454 square miles, or 290,560 acres.

The northeastern quarter of Colorado, of which this area is a part, comprises an eastward-sloping plain which ranges in elevation from slightly less than 5,000 feet above sea level at Fort Collins, lying at the lower slope of the foothills, to 3,745 feet at Holyoke, near the Nebraska line, 150 miles to the east.

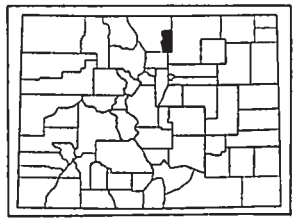

FIGURE 1.—Sketch map showing location of the Fort Collins area, Colorado

The gradual rise of this plain toward the west, at the rate of slightly more than 8 feet a mile,[1] is fairly uniform to the lower foothills which extend through the western part of the Fort Collins area.

The foothills consist of a series of ridges extending north and south with long slopes toward the east and shorter, rocky slopes toward the west. These ridges, underlain by the upturned edges of the sedimentary rocks underlying the plain, increase in height toward the west until the igneous rocks which form the core of the mountains are reached, beyond the limits of this area. Between the ridges are long, narrow lowland belts, or glades, the larger of which are under cultivation and have been included in the area surveyed. The tops of the ridges and the rocky western slopes are nonagricultural except for grazing purposes.

East of the foothills and occupying the main area covered by the survey is a series of low north-and-south ridges and alternating valleys, formed in the same way as those mentioned. Here, however, the west slope is less steep and the material not so hard as in the foothill region, and soil has developed to a considerable depth on both slopes.

Three comparatively large streams cross the area from west to east; Cache la Poudre River in the northern part, Thompson River in the south-central part, and Little Thompson River in the extreme southern part. All drainage from the Fort Collins area is carried beyond the limits of the area into South Platte River.

[1] UNITED STATES GEOLOGICAL SURVEY. LOVELAND QUADRANGLE. U. S. Geol. Survey Sheet 1905-6.

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In addition to the streams a very large number of natural and artificial lakes are used as storage reservoirs for irrigation waters. The lake basins are believed to have been formed partly through erosion by the wind. Wind erosion in lake-basin formation seems to have been of considerable importance and has been caused by the prevailing strong west winds, the soft and, in many places, dry condition of the rock formations, and the steep westward-facing escarpments of the ridges. The longer dimensions of the lakes, or basins, which occur in more or less well-defined chains or belts, are in general from north to south or from northwest to southeast. These basins have been greatly enlarged by artificial means, principally by dams across the lower part, or outlet, and many have been made, where no natural basin existed, by damming small streams.

The larger part of the area covered by this survey is under irrigation. The water supply, which is fairly abundant, is furnished by direct flow from the streams early in the season, and later in the season it is supplemented by water from the reservoirs.

These streams rise in the snow-capped mountains to the west and are fed throughout the summer by melting snow and numerous small high-mountain lakes and streams. As the larger streams flow eastward they cut across the foothill ridges and valleys almost at right angles and receive small tributary streams from the north and south. Here the current is swift, and the channels in most places are narrow and rocky. Beyond the limits of the foothills the currents are less swift, the channels less rocky, and the streams are bordered by rather wide flood plains. Along Cache la Poudre River the flood plain ranges from one-fourth to more than a mile in width; the flood plains along Thompson and Little Thompson Rivers are somewhat narrower. The flood plains, which have been subject to overflow in comparatively recent times, are bordered in places by old flood plains, or terraces, which lie at elevations ranging from 10 to 40 or more feet above the recent, or lower, flood plain. The stream side of the terraces is in most places sharp and well marked by a steep gravel-covered slope. The outer edge, however, is less well defined and in places can not be definitely determined, owing to the gradual slopes of the adjacent uplands. Soil material carried in by small tributary streams and wind-blown material have also aided in obliterating the outer terrace limits.

These old valleys or terraces are in many places much wider than the present valleys but are not continuous, extending in places along one side of the stream or the other and in other places along both sides. The surface is nearly smooth and slopes gently toward the adjacent valley and also downstream. For this reason the old terrace plains have been comparatively easy to irrigate, and they now form the more important parts of the best irrigation districts. On them all the important towns of the area have been located.

In places the old stream terraces merge with smooth, gently sloping outwash plains which extend eastward from the steeper foothills. Through these plains flow small tributary streams which doubtless have played an important part in their development. Plains of this kind extend west and southwest from the old terrace of Cache la Poudre River, south of Fort Collins, and both northwest and southwest of Thompson River, west of Loveland.

In the northern part of the area are parts of an older, much higher outwash plain which extends beyond the limits of the area to the north, and in several places within the area are hills which seem to be small remnants of the same plain.

Boxelder Creek and Dry Creek, which enter the area from the north, have carried much material down into the valley of Cache la Poudre River. Boxelder Creek is bordered by a comparatively wide valley, especially along the west side, but has no well-defined high terraces. Of the streams which drain the small interridge valleys, Buckhorn Creek is the most important both in size and in the amount of soil material which it has carried down into the valley of Thompson River.

Settlement and development of the area has been closely associated with and dependent on the development of irrigation. The first irrigators in Colorado were Mexicans, who established themselves in the southern part of the State, built small ditches, and cultivated small farms. The present irrigation system of Colorado had its birth in the northern part of the State along South Platte River and its tributaries. Along the branch of the overland trail which followed South Platte and Cache la Poudre Rivers, ditches were built near stage stations as early as 1860. The beginning of colony enterprises at Greeley, Longmont, and Fort Collins came 10 years later, and from that time to the present, farming by means of irrigation has been recognized as one of the important industries of the State. The era of corporate canal building began in 1878, and six years later the State engineer estimated that 1,000,000 acres had been reclaimed in the State. The census of 1920 reported a total of 3,348,385 acres irrigated in Colorado, of which more than 500,000 acres were added in the preceding 10 years. By the construction of additional storage reservoirs, both in the mountains and in the irrigated regions, the area under irrigation has been increased since that time.

Larimer County has a population of 33,137, according to reports of the United States census of 1930.[2] Although the Fort Collins area covers only slightly more than one-sixth of the county, it includes a very large part of the population. The population of Fort Collins is 11,489, of Loveland 5,506, of Berthoud 811, of Wellington 533, and of Timnath 169.

According to the 1920 census about 87 per cent of the inhabitants are native-born whites. The foreign-born population includes Germans, Russians, Mexicans, and a few Japanese. There are a few negroes in the area.

Fort Collins, Loveland, and Berthoud are the principal towns in the area. Denver, 65 miles south of Fort Collins, is the principal market for livestock, farm, dairy, bee, and poultry products. A part of the livestock is shipped east to Omaha and Chicago. Factories of the Great Western Sugar Co. at Fort Collins and at Loveland furnish markets for sugar beets grown in the area. Alfalfa and much of the oats, barley, and corn grown are fed to sheep, cattle, and dairy cows. The feeding of sheep and lambs on beet pulp and alfalfa has, for several years past, been an important industry. Practically no feed

[2] Soil survey reports are dated as of the year in which the field work is completed. Later census figures are given whenever possible.

is shipped out of this area. Apples, small fruits, and garden products are grown extensively and sold in the local markets and from numerous roadside stands. The summer resorts of Estes Park and other near-by mountain regions also furnish an important market for such products.

The area is well supplied with railroad facilities by several branches of the Colorado & Southern Railway and by the Great Western Railway, which are within the area, and by the Union Pacific and the Chicago, Burlington & Quincy Railroads, which are outside the area.

A hard-surfaced road extends from Cheyenne on the north through the central part of the area to Denver on the south. This connects at Fort Collins with a highway which extends west over Cameron Pass to North Park and northwestern Colorado and through Greeley to the east. It also connects at Loveland with a highway extending into Rocky Mountain National Park and to the west. Other roads in the area are good, many being hard surfaced.

CLIMATE

Colorado is noted for its rare and exhilarating atmosphere, which is owing to the high altitude, the low atmospheric pressure, and the low relative humidity.

The mean annual temperature at Fort Collins is 46.4° F. January is the coldest month and July the hottest. Owing to the low humidity, extremes of temperature cause less discomfort than in places where the climate is more humid.

The average annual snowfall at Fort Collins is 42.8 inches, but in the mountains to the west is much greater. The deep snow banks are of almost incalculable value, as they form a moisture reserve that feeds numerous small streams throughout the year. The snow which falls on the cultivated lands provides a supply of moisture, much of which is stored in the soil until needed by growing crops.

The average yearly rainfall at Fort Collins is 14.77 inches. January is the driest month of the year, December, November, February, and March following in the order named. The average precipitation is less than 1 inch a month for these five months. April and May are the months of greatest precipitation, with July, June, September, August, and October following in the order named.

At Denver the sky is clear on an average of 151 days a year, as shown by a record of 53 years. The average velocity of the wind at Denver is 7.4 miles an hour.

The average length of the frost-free season, or the period between the average date of the latest and earliest killing frosts is 142 days at Fort Collins. The date of the latest frost on record is June 3 and of the earliest is September 7. Crop growth is remarkably rapid, and many of the crops mature in considerably less time than is required in some regions where the growing season is longer.

These climatic conditions allow more successful dry farming than can be carried on farther south where the rainfall is about the same. Climatic conditions seem especially favorable for the crops grown. Small fruits are highly flavored, and brilliant flowers of many kinds grow luxuriantly. The greatest hazard in crop production is the danger of injury from hail.

Table 1 gives the normal monthly, seasonal, and annual temperature and precipitation at Fort Collins.

TABLE 1.—*Normal monthly, seasonal, and annual temperature and precipitation at Fort Collins, Larimer County, Colo.*

[Elevation, 4,985 feet]

Month	Temperature			Precipitation			
	Mean	Absolute maximum	Absolute minimum	Mean	Total amount for the driest year (1893)	Total amount for the wettest year (1923)	Snow, average depth
	°F.	°F.	°F.	*Inches*	*Inches*	*Inches*	*Inches*
December	27.2	72	−35	0.46	0.12	0.25	6.3
January	26.2	69	−31	.44	(1)	.19	3.4
February	27.4	70	−38	.61	.10	1.39	8.8
Winter	26.9	72	−38	1.51	.22	1.83	18.5
March	35.0	81	−25	.93	.14	2.74	8.5
April	44.8	86	−4	2.13	.66	2.18	6.9
May	53.8	88	12	2.84	1.92	4.46	1.4
Spring	44.9	88	−25	5.90	2.72	9.38	16.8
June	63.1	97	30	1.49	.26	6.23	.0
July	68.0	100	36	1.83	.64	4.50	.0
August	67.5	100	32	1.22	.92	.62	.0
Summer	66.2	100	30	4.54	1.82	11.35	.0
September	59.2	95	22	1.28	.18	1.36	.2
October	48.0	87	−8	1.07	.16	3.55	2.7
November	36.1	76	−21	.47	.55	.10	4.6
Fall	47.8	95	−21	2.82	.89	5.01	7.5
Year	46.4	100	−38	14.77	5.65	27.57	42.8

[1] Trace.

AGRICULTURE

Crops grown in this part of Colorado prior to extensive cooperative irrigation about 1870 were primarily for home use and for local demand. Up to 1900, when metal mining in Colorado reached its peak, the mining towns afforded a ready market for much of the products of the farms. Truck and garden crops, fruits, and poultry and dairy products were produced to a considerable extent to supply this demand. Later, with the installation of extensive irrigation systems, general farming and livestock raising on a larger scale were undertaken and have continued to increase in importance year by year.

In the production of various crops in 1920 Colorado ranked among the States as follows: Sugar beets, first; potatoes, ninth; barley, eleventh; apples, thirteenth; peaches, fourteenth; rye, fourteenth; wheat, seventeenth; hay and forage, seventeenth; oats, nineteenth; vegetables, twenty-second; small fruits, twenty-sixth; and corn, twenty-eighth.

The main cash crops in the Fort Collins area at the present time are sugar beets, alfalfa, wheat, barley, corn, dairy products, truck and garden products, apples and small fruits, bee products, and flowers, ranking about in the order named.

In 1926 the total value of crops in Larimer County, the larger part of which were grown in the Fort Collins area, were as follows:[3] Sugar

[3] COLORADO STATE BOARD OF IMMIGRATION. YEAR BOOKS OF THE STATE OF COLORADO. . . . Compiled and edited by T. R. Ingram, Denver, 1926 and 1927.

beets, $2,055,855; hay, $1,313,350; wheat, $776,020; fruits, $332,670; miscellaneous crops, $220,402; barley, $170,150; corn, $155,490; oats, $124,970; potatoes, $51,350; beans, $16,215; sorghums, $1,930; and rye, $1,065; a total of $5,219,467.

The acreages and average yields of the principal grain crops in Larimer County in 1926 were as follows: Winter wheat, irrigated, 8,910 acres, average yield 36 bushels an acre; nonirrigated, 7,690 acres, average yield 15 bushels; spring wheat, irrigated, 8,680 acres, averag- yield 33 bushels; nonirrigated, 760 acres, average yield 9 bushels; bare ley, irrigated, 7,320 acres, average yield 40 bushels; nonirrigated, 920 acres, average yield 18 bushels; corn, irrigated, 5,630 acres, average yield 30 bushels; nonirrigated, 5,010 acres, average yield 10 bushels; and oats, irrigated, 6,330 acres, average yield 42 bushels; nonirrigated, 1,010 acres, average yield 18 bushels.

The acreages of hay crops in 1926 in Larimer County were as follows: Alfalfa, 60,790 acres; wild grass cut for hay (principally outside of the area surveyed), 4,415 acres; oats cut green for hay, 1,800 acres; other tame grasses, 1,160 acres.

In the same year the acreages of important miscellaneous crops were as follows: Sugar beets, 19,430 acres; beans, 1,930 acres; garden peas, 360 acres; and snap beans, 80 acres.

The number of all cattle as reported by the United States census, January 1, 1925, was 43,491, of which the great majority were beef cattle. The number of sheep at this time was 422,324. The number of chickens raised in 1924 was 163,576, and the value of eggs produced was $159,464.

There is a very direct and fairly well-recognized relationship existing between crops and soils. The growth of sugar beets, the most important money crop of the area, is confined very largely to the more productive soils. These are the loams and clay loams of the Fort Collins series, the loams and fine sandy loams of the Weld series, and the deeper and better-drained soils of the Cass series. Alfalfa is, to a large extent, grown on these soils but is also grown on less productive soils, especially on the heavy soils of the Terry series. Wheat and, to less extent, barley, are grown on the better soils extensively and on these soils give the largest yields, but these crops are grown without irrigation on soils of lower grade. Oats are grown largely on soils of the Neville series and to less extent on rather poorly drained soils of other series. Cherries are grown very largely on the fine sandy soils of the Terry series. The growing of garden truck and small fruit is confined very largely to sandy soils of the Fort Collins and Cass series.

Farming methods as a whole are good. Sugar beets are grown under the supervision of field men of the Great Western Sugar Co., the hand labor, as a rule, being done by contract. The production of sugar beets is confined to soils which will produce, under good handling and a fair season, a crop that will yield a profit. Recent infestation of nematodes has caused condemnation of certain fields until other crops have been grown sufficiently long to eradicate this pest. Wheat is to a large extent cut with binders and threshed from the shock or stacked. Combines are also being used, especially on the nonirrigated lands.

Commercial fertilizers, especially phosphate, are used to some extent on sugar beets. The greater part of the soil is, however,

kept in a high state of productiveness by the use of large quantities of manure. This is obtained to a large extent from sheep, beef cattle, and from the dairy herds.

Farm buildings and equipment in general are good, consisting of a well-built farmhouse, barns, and other buildings, good fences, and an abundance of farm machinery. In 1926 there were in Larimer County 27 farm trucks, 84 tractors, and 154 silos.

Labor, which is very largely white, either American or foreign born, is efficient and fairly abundant. Day wages for farm laborers in Colorado in 1924 were on the average $2.30 with board and $3.30 without board. Monthly wages averaged $40.80 with board and $60.30 without board.

In 1930 the number of farms in Larimer County was 1,852, and the average size of farms was about 200 acres, but in the Fort Collins area, a large part of which is irrigated, the average size is considerably less. Of the farms in Larimer County 1,154, or 63.4 per cent, were operated by the owners, the remainder being operated largely by renters. There were 362 farms ranging in size between 175 and 500 acres, 443 between 100 and 175 acres, 478 between 20 and 100 acres, and 298 between 3 and 20 acres.

The price of well-improved land on which Fort Collins loam, Fort Collins clay loam, or Weld loam, smooth phase, is the predominating soil probably ranges between $175 and $225 an acre. The price of improved land on which Weld loam, Weld sandy loam, Cass clay loam, Cass fine sandy loam, or Cass silt loam, red phase, predominates probably ranges between $125 and $175 an acre. Less desirable land is held at lower prices.

SOIL SERIES AND TYPES

In soil classification, the soils of an area are divided into groups called series. The soils of each series, or the soil types, have one or more common characteristics, which may be the result of weathering, of the source of the parent material, or of some other cause, but they are separated on the basis of texture, or the proportion of sand, silt, and clay in the surface soil. Within the soil types there are also variations. Where these are sufficiently well defined and of importance they may be indicated as phases of the types.

Soils of the Fort Collins series are characterized by dark-brown or slightly reddish-brown surface soils, distinctly lighter-brown subsoils with light-colored spots of lime material, and purplish-brown and gray limy and gravelly material in the deeper part of the subsoils. They are well drained, have good or fair underdrainage, are comparatively free from alkali, and are highly productive. They occupy broad stream terraces or bench lands adjacent to the larger streams of the area.

Soils of the Weld series are characterized by dark-brown or olive-brown surface soils, lighter-colored olive-gray subsoils with white spots of lime accumulation, and lower subsoil layers of the same color but of lighter texture and having, where exposed to weathering, an irregular columnar structure. These soils have developed largely from wind-blown or loess material, probably mainly of local origin, and they occupy hilly, undulating, and nearly level areas of upland. They are, for the most part, well drained and free from alkali, are rather easy to cultivate, and are productive.

Soils of the Terry series have dark-brown or dark olive-brown surface soils, slightly lighter olive-brown or olive-gray subsoils with light-colored spots of lime accumulation, and partly disintegrated shale or sandstone of about the same color in the lower part of the subsoil. These soils have resulted from the weathering in place of shales and sandstones, principally of the Pierre formation, the heavier soils being from shale and the lighter from sandstone. They occupy hilly, undulating, level, and basinlike upland areas and are closely associated with soils of the Weld series. In many places they occupy steep slopes, rims of basins, and lower-lying areas adjacent to higher areas of the Weld soils. In many places they contain alkali in harmful amounts, are difficult to cultivate, and are only moderately productive.

The Larimer soils are characterized by brown or reddish-brown surface soils, deeper reddish-brown upper subsoil layers, and grayish-brown gravelly lower subsoil layers containing spots of purplish-brown outwash material and large amounts of lime. Gravel, both sharp and waterworn, are abundant on the surface and through the surface soil and subsoil. These soils occupy old outwash fans, the material of which has come from both the granitic material of the high mountains and the red sandstone of the foothills. These materials have been carried down by the streams and spread out over the edge of the plain below the steeper slopes. The soils have developed under two rather widely different conditions. West and southwest of Fort Collins a large area of outwash material of this kind has in comparatively recent times been deposited by small streams entering the plain through Soldiers Canyon and Spring Canyon. This outwash plain is a continuation of the old river terrace on which the Fort Collins soils have developed. In the northern part of the area the soils of this series have developed from a much older, higher, and more gravelly outwash plain which in places has been modified by deposits, largely from red sandstone, brought down by Dry and Boxelder Creeks. Soils of this series include areas that are fairly productive, but as a whole they are of lower value than are soils of either the Fort Collins or the Weld series.

Soils of the Berthoud series are characterized by dark olive-brown surface soils, lighter olive-brown upper subsoil layers, with white spots indicating an accumulation of lime, and nearly white or pinkish-gray lower subsoil layers, very high in lime. They have a nearly level or gently sloping surface and occur as outwash fans deposited by small streams which have their source in soft shale and limestone beds. Considerable areas of soils of this series lie southwest and northwest of Berthoud at the foot of the steeper hill slopes and also northwest of Loveland in the same position. They are used principally for dry farming and are moderately productive.

The soils of the Laporte series have brown or light-brown surface soils which contain very small fragments of thin nearly white calcareous shale or shaly limestone. The surface soils are underlain by lighter-brown material containing a larger percentage of shaly fragments and larger amounts of lime. At a depth ranging from 15 to 36 inches, the partly disentegrated shaly limestone is reached. The deeper areas of these soils are used for dry farming, but yields are usually low. They are also used to some extent for orchards and for small fruits. In this area these soils occur in broken belts along the foothill slopes and on narrow ridges.

The Neville soils are characterized by red, dull-red, or brick-red surface soils, heavier and redder subsoils, and red sandstone or shale parent material which is reached at a slight depth in many places. They occupy the small valleys and glades between red sandstone and shale ridges and where farmed are rather productive.

The soils of the Greeley series have brown or dark grayish-brown surface soils, underlain by lighter-brown slightly heavier material, which is in turn underlain by lighter-textured material. These soils have developed from recent-alluvial material and occupy uneven terraces or ridges. Some areas are productive, but as a whole the soils are less productive than soils of the Fort Collins series.

Soils of the Cass series are characterized by nearly black, dark-brown, or reddish-brown surface soils and very slightly lighter-brown and in many places heavier subsoils. Waterworn gravel, fine sand, and finely divided mica are distributed through the surface soils and subsoils.

These soils occupy the valleys of the three large streams of the area and of some of the small streams which have their source in the granitic rocks and the red sandstone valleys. There is, however, some variation in the soils of the different large valleys. Those in the flood plain of Thompson River are deeper reddish brown and in places more micaceous than those in the valley of Cache la Poudre River, and those in the flood plain of Little Thompson River are slightly coarser than those along the other two streams.

Considerable areas of soils of this series are deep, well drained, easy to cultivate, and highly productive. Other areas, however, are shallow, gravelly, and have a high water table. Some are heavy and difficult to handle and some contain alkali in considerable amounts.

The individual soil types of each series are described in the following pages, and their distribution in the area is shown on the accompanying soil map. Table 2 gives their acreage and proportionate extent in the area.

TABLE 2.—*Acreage and proportionate extent of the soils mapped in the Fort Collins area, Colorado*

Type of soil	Acres	Per cent	Type of soil	Acres	Per cent
Fort Collins loam	23,488	8.7	Larimer loam	6,080	2.1
Light-textured phase	1,664		Larimer gravelly loam	5,952	2.1
Fort Collins clay loam	4,736	1.6	Larimer fine sandy loam	3,648	1.6
Fort Collins fine sandy loam	1,472	.5	Level phase	1,088	
Fort Collins very fine sandy loam	1,664	.6	Berthoud loam	5,632	2.5
Fort Collins loamy fine sand	1,216	.4	Heavy phase	1,600	
Greeley fine sandy loam	4,288	1.5	Laporte loam	5,824	2.0
Greeley loam	1,472	.5	Laporte shaly loam	6,144	2.1
Weld loam	26,752		Neville fine sandy loam	7,296	2.9
Valley phase	7,232	14.8	Colluvial phase	1,088	
Smooth phase	9,088		Neville loam	2,176	.7
Weld fine sandy loam	15,744	6.5	Cass fine sandy loam	17,600	
Valley phase	3,136		Red phase	4,800	
Weld loamy fine sand	1,024	.4	Gray phase	2,752	10.1
Terry silty clay loam	17,024	9.3	Colluvial phase	2,560	
Valley phase	9,984		Shallow phase	1,344	
Terry loam	1,536		Cass clay loam	4,736	2.0
Heavy-subsoil phase	1,728	1.5	Colluvial phase	1,152	
Valley phase	1,280		Cass silt loam, red phase	3,328	1.1
Terry fine sandy loam	14,848	5.8	Cass loam	512	.2
Valley phase	1,984		Rough mountainous land	49,216	16.9
Terry loamy fine sand	2,176	1.6			
Brown phase	2,496		Total	290,560	

FORT COLLINS LOAM

Fort Collins loam is the most extensively developed soil of the Fort Collins series and is the most important agricultural soil in the area surveyed. It occupies level belts bordering each of the main stream valleys. In this soil type the general characteristics of the soils of the Fort Collins series are well developed. The dark-brown or dark slightly reddish-brown surface layer extends to a depth of 12 or 14 inches, where it gives place abruptly to a lighter-brown material which, when moist, has a slightly pinkish-brown or salmon-colored tint. This line of color change is readily seen in roadside cuts or in ditch or gully banks. The second layer is slightly heavier in texture and has distributed through it small light-gray spots, from one-eighth to one-half inch in diameter, which effervesce very freely with acid, indicating a high lime content. They are normally most abundant between depths of about 24 and 30 inches. The third layer, beginning at a depth ranging from 30 to 36 inches, is much like the layer above it in the upper part but is practically free of lime spots. Below this at various depths, but generally within 5 feet of the surface, reddish-brown, purplish-red, and gray very micaceous soil material containing varying amounts of lime, sand, and waterworn gravel is reached.

The dark-colored surface layer, in the virgin soil or where the land has not been cultivated for a long time, has a finely granular surface mulch, from 1½ to 2 inches thick, which forms a thin easily broken crust when the soil is dry. On exposure and drying the surface soil breaks into rather hard angular clods from one-eighth to one-half inch in diameter. Worm holes and plant roots are abundant. The second, or light-colored, layer on weathering also breaks into hard clods somewhat smaller than those of the surface layer, and a slight accumulation of white material is apparent, in places, along the cleavage planes and on the vertical surface where the material is exposed in cuts and ditch banks. The third layer has a more massive structure when dry and in places shows a tendency toward a columnar structure.

This soil varies in depth and in character of the deep subsoil across the terrace and also along the terrace or up and down stream. On the stream side of the terraces and in places adjacent to small streams the soil layers are not so deep and the subsoil is more gravelly, with a greater proportion of large gravel, than on the opposite side of the terrace. The texture is also lightest near the terrace edge and tends to grade heavier in the opposite direction. In general, the soils are less deep, are slightly lighter in texture, and contain more gravel in the part of the terrace highest upstream than in the lower parts. This is especially noticeable along Cache la Poudre River where the terraces extend westward into the outwash fans. Variations in color also occur. Upstream the soil contains a larger proportion of material from red sandstone and shale and is more reddish brown than it is downstream. The soil developed on the terraces of Thompson River are, as a whole, somewhat redder and contain much less gravel than those on the terraces of Cache la Poudre River. Local variations from place to place are due to differences in surface drainage and underdrainage conditions, the lower-lying and less well-drained soils being, as a rule, the heaviest.

Fort Collins loam occupies a total of 36.7 square miles, almost equally divided among the terraces of the three large streams. The more important areas are south and southeast of Fort Collins, along the north side of Thompson River both east and west of Loveland, and on the north side of Little Thompson River both east and west of Berthoud.

All the areas have a nearly smooth surface with a general slope downstream and toward the river flood plain, which gives good surface drainage. Underdrainage is also good, but the limy layer of the deeper part of the subsoil probably checks downward movement of water and at times the subsoil is very wet from excessive use of irrigation water. Little of this soil has received or is in need of artificial drainage. It is all under cultivation and is highly productive.

The important crops are sugar beets, small grains (principally wheat and barley), alfalfa, and corn. The average yield of sugar beets on this type of soil is probably more than 15 tons to the acre, and yields of 20 tons or more are frequently produced. According to the figures of the Great Western Sugar Co. the average yields of sugar beets in the Harmony district, where Fort Collins loam is the most extensively developed soil type, have been as follows: 1924, 13.82 tons to the acre; 1925, 11.93 tons; 1926, 17.55 tons; and 1927, 15.03 tons.

The average acre yield of wheat, according to estimates by the chief agronomist of the State Agricultural College, is about 30 bushels, with yields as high as 70 bushels recorded. (Pl. 1, A.) The average yield of corn is around 50 bushels, of barley about 60 bushels, and of oats 60 bushels. Yields of 85 bushels of barley and 100 bushels of oats are not uncommon.

This land is kept in a high state of productiveness by rotating crops and by the use of large quantities of manure. On account of the fair profits to be made from growing sugar beets where large yields are obtained the acreage of beets during the last few years has been large, and some fields have been used almost continuously for this crop.

Fort Collins loam, light-textured phase.—The light-textured phase of Fort Collins loam occupies small strips near the north edge of terraces south of Cache la Poudre River. The largest area extends through the center of the city of Fort Collins.

This light-textured soil consists of fine-textured loam or rather heavy fine sandy loam having about the same thickness and arrangement of layers as the typical loam. It has a good deep subsoil, the lower light-brown layer in places extending to a depth of 5 or more feet with little change in color or texture. The soil is easy to cultivate, is well drained, and when moist is slightly less sticky than typical Fort Collins loam. It has a slightly wider range of crop adaptation than the typical soil and is especially well suited to intensively cultivated crops. Yields are about the same or possibly a little higher than on the typical soil.

In Table 3 are given the results of mechanical analyses of samples of the surface soil, the subsurface soil, and several layers of the subsoil of typical Fort Collins loam.

TABLE 3.—*Mechanical analyses of Fort Collins loam*

No.	Description	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
		Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
490881	Surface soil, 0 to 2 inches	0.8	4.8	3.2	18.0	30.8	27.5	14.5
490882	Subsurface soil, 2 to 12 inches	1.5	4.2	3.0	16.1	27.8	29.0	18.0
490883	Subsoil, 12 to 30 inches	.9	1.2	.7	3.8	27.3	44.9	21.6
490884	Subsoil, 30 to 54 inches	.5	1.4	1.0	5.8	24.9	40.9	25.6
490885	Subsoil, 54 to 84 inches	1.8	4.5	2.8	11.3	22.3	30.9	26.5

FORT COLLINS CLAY LOAM

Fort Collins clay loam is dark-brown or slightly reddish dark-brown heavy loam or clay loam to an average depth of about 14 inches. Below this and marked by a sharp change in color is light-brown clay loam with light-colored spots, principally of lime accumulation. Below a depth ranging from 30 to 36 inches the material is practically free of lime spots and is slightly lighter in texture. Normally this layer extends to a depth of 60 or more inches with little change in color or texture, and below that depth it is underlain by reddish-brown and purplish-brown material characteristic of the lower part of the subsoil of the Fort Collins soils.

The virgin soil or that in uncultivated fields has a rather deep and well-crusted surface mulch. The soil, as a rule, is slightly darker brown, and the adobe structure where the soil is exposed to weathering is slightly more pronounced than in Fort Collins loam.

Surrounding the low hill west of Warren Lake is a small area in which partly disintegrated sandstone is reached in the deeper part of the subsoil.

Fort Collins clay loam covers an area of 7.4 square miles southeast of Fort Collins, known as the Harmony neighborhood. The soil is suited to the same crops as Fort Collins loam and the light-textured phase of that soil. This land produces good crop yields, but it is more difficult to handle than Fort Collins loam and the subsoil is not so well drained. There is also slightly more variation in texture and in surface drainage and underdrainage conditions than in the loam.

FORT COLLINS FINE SANDY LOAM

The surface soil of Fort Collins fine sandy loam is brown, dark-brown, or slightly reddish dark-brown light-textured fine sandy loam containing a small amount of sharp coarse sand and fine sharp and waterworn gravel. At a depth of about 12 inches it is underlain by light-brown or grayish-brown somewhat heavier fine sandy loam which also contains sharp sand and gravel and has distributed through it light spots of lime accumulation and in places a white coating on the gravel. (Pl. 1, B.) Below a depth of 30 inches is dull-red or purplish-red gravelly fine sandy loam. Considerable waterworn gravel is scattered over the surface in places and distributed through the surface soil and subsoil.

This soil is rather variable and includes, especially along the river side of the areas in which it occurs, considerable areas of brown or slightly reddish-brown loamy fine sand of wind-blown origin, much of which is believed to be a comparatively recent deposition, and the layer of lime accumulation has developed but slightly.

This soil is not extensive, its total area being only 2.3 square miles. The largest area extends along the river side of the old stream terrace on which Fort Collins is situated. In places there is a lower terrace of considerable extent, a large part of which is rather sandy, occupied by this soil.

Fort Collins fine sandy loam is easy to cultivate, and on account of its sandy character and good drainage it is warm and well suited to the growing of vegetables and small fruits, for which it is extensively used.

FORT COLLINS VERY FINE SANDY LOAM

Fort Collins very fine sandy loam has a brown or dark grayish-brown surface soil to a depth of about 12 inches, below which is light grayish-brown light-textured very fine sandy loam containing white spots of lime accumulation. The line between the dark and light colored layers is sharp and clearly marked. The lighter-colored layer extends to a depth of about 30 inches, where it is underlain by soil which is very slightly lighter and free from lime spots. This material extends to a depth of 60 or more inches.

This soil covers a total of 2.6 square miles in the east-central part of the area surveyed, the bodies lying from 4 to 7 miles southeast of Timnath. As the soil occupies smooth gently sloping areas approximately 100 feet higher than the adjacent valley of the Cache la Poudre River, its inclusion in the Fort Collins series is questionable.

This is an easily cultivated, well-drained, and productive soil.

FORT COLLINS LOAMY FINE SAND

Fort Collins loamy fine sand, to a depth of about 15 inches, consists of dark-brown or dark reddish-brown micaceous loamy fine sand containing a small amount of small sharp gravel. Below this is light-brown loamy fine sand with but slight indications of lime accumulation and containing some small sharp gravel. This material is underlain at a depth of about 30 inches by fine sand.

This soil, like that along the outer edge of the terrace bordering the Cache la Poudre River Valley, is believed to be largely of wind-blown and comparatively recent origin.

Fort Collins loamy fine sand occurs along both sides of the Thompson River Valley. Its total area is small, and it is of rather low agricultural value.

GREELEY FINE SANDY LOAM

Greeley fine sandy loam has a brown or dark grayish-brown fine sandy loam surface soil, extending to a depth of 8 or 10 inches, below which is lighter-brown slightly heavier fine sandy loam containing a few small white spots of lime carbonate. The line of color separation between this layer and the darker surface layer is less sharply marked than in the soils of the Fort Collins series. The second layer extends to a depth of about 24 inches, at which depth it grades into much lighter-textured brown or reddish-brown fine sandy loam. Some included areas are rather sandy and gravelly.

Greeley fine sandy loam has developed largely from soil material carried down from the upland areas to the north by Dry Creek, Boxelder Creek, and other small streams, and deposited as ridges and poorly developed terraces along the outer edge of the Cache la

Poudre River Valley and in places in the valley of Boxelder Creek. It covers a total area of 6.7 square miles. The terrace on which the town of Timnath is situated is fairly well developed, but much of the area covered by this soil consists of uneven ridges, in places but slightly higher than the adjacent stream valley.

This soil in some areas is fairly productive, but as a whole it is less productive than Fort Collins fine sandy loam.

GREELEY LOAM

On the north side of the Cache la Poudre River Valley, north and east of Timnath, are a few low ridges covered with brown soil which has been mapped as Greeley loam.

The surface soil consists of brown loam to a depth of about 12 inches, below which light-brown heavy loam containing spots of lime carbonate extends to a depth of 30 or more inches. This layer is underlain by lighter loam, sandy loam, and gravel. Sharp granitic gravel and some waterworn gravel occur on the surface and distributed through the surface soil and subsoil.

This soil is of slightly lower agricultural value than Fort Collins loam or its light-textured phase.

WELD LOAM

Weld loam consists of dark-brown or dark grayish-brown loam to a depth of about 12 inches, at which depth it is underlain by distinctly lighter-brown, grayish-brown, or olive-brown loam of slightly heavier texture which contains well-defined nearly white lime spots from one-half inch to 1½ inches in diameter. At a depth of about 36 inches the material grades into a more friable lower subsoil layer which contains very few lime spots. The subsoil extends to a depth of 60 or more inches.

Uncultivated areas of this soil have a thin surface mulch of finely granular and rather sandy material moderately crusted at the surface. Below this mulch the surface soil when dry breaks into hard somewhat regular clods with smooth surfaces. The upper part of the lighter-colored layer also breaks into fairly hard somewhat regular clods which in places have a thin coating of limy material over their surfaces.

The third layer has a rather distinctly columnar structure characteristic of all wind-blown soils, the vertical cleavage planes of which allow free movement of moisture, air, and plant roots. In places fine rootlets are found nearly covering the face of the cleavage planes at a depth of several feet below the surface.

Readings made of the resistance of this soil at various depths indicate a slight concentration of soluble salts in the middle layer.

This soil has developed largely from material believed to have been blown from the soft shale and sandstones of near-by regions and to some extent from the river flood plains. Owing to differences in the materials from which the soil has developed, depth of soil material, and relief, this soil includes rather wide variations. Near outcrops of sandstone it tends to be lighter in texture than areas in which all of the parent material is from shale. Where the loess deposit is shallow the soil is, as a rule, heavier than where the loess is deep. Where the surface is nearly level the subsoil is more completely developed and heavier than where the soil occupies slopes. In the extreme

southeastern part of the area surveyed a body of soil in which dark-colored partly disintegrated shale is reached at a depth below 4 feet has been included with the typical soil.

Weld loam occupies a large proportion of the area covered by the Weld soils, which are the predominating upland soils east of a line from Waverly south through Fort Collins, Loveland, Campion, and Berthoud to the south limits of the surveyed area.

Weld loam includes a total area of 41.8 square miles. Nearly all the land is under irrigation and, with the exception of Fort Collins loam, this soil probably has higher average productiveness than any other soil in the area.

Weld loam, valley phase.—The valley phase of Weld loam differs from the typical soil principally in being slightly darker brown at the surface, in having a less well-drained lower subsoil layer, and in having slight accumulations of alkali in places. Soil of this phase requires slightly less irrigation water than the typical soil. It occupies level or nearly level areas, lower slopes which have received recent colluvial and wind-blown deposits, and broad valleylike areas. It is most typically developed between Plummer and Wellington.

Weld loam, smooth phase.—The smooth phase of Weld loam differs from the typical soil in having a more nearly smooth well-drained surface and in having, in places, a slightly reddish-brown loam or clay loam lower subsoil layer, somewhat similar to that of the Fort Collins loam near Loveland. This soil is intermediate between the Weld and Fort Collins soils.

A considerable area of this smooth soil extends from Campion eastward, occupying the divide between the valleys of Thompson and Little Thompson Rivers. It is slightly more productive than the typical soil.

Weld loam, smooth phase, is used extensively for sugar beets (pl. 2, A), wheat, barley, alfalfa, and corn.

WELD FINE SANDY LOAM

Weld fine sandy loam is closely associated with Weld loam, especially in that part of the area north of Cache la Poudre River. It consists of brown or dark-brown fine sandy loam to a depth of about 12 inches, below which is light-brown or slightly olive-brown heavier-textured fine sandy loam containing light-gray spots of lime accumulation. Below a depth ranging from 30 to 36 inches the color remains the same but the texture is slightly lighter and the lime spots are less well developed or are absent. This layer extends to a depth of 5 or more feet.

The dark-colored upper layer is slightly crusted and is finely granular to a depth of 1 or 2 inches, below which it breaks into somewhat regular clods which are very easily crumbled. The second layer breaks into somewhat harder regular clods, and below this the columnar structure noted in Weld loam is well defined.

This soil differs from Weld loam principally in texture. On the more rolling and small hilly areas are spots from which the surface soil has been partly eroded by the wind.

Weld fine sandy loam occupies a total of 24.6 square miles, principally north and east of Plummer. The areas in many places are adjacent to ridges on which soft sandstone outcrops or has only a shallow soil covering.

This soil is used for the same crops and handled in the same way as Weld loam, but is, as a whole, somewhat less productive.

Weld fine sandy loam, valley phase.—The valley phase of Weld fine sandy loam bears the same relation to the typical fine sandy loam as the valley phase of Weld loam bears to its typical soil. It is slightly darker, is a little heavier in texture, requires the application of less water, has in places small areas in which alkali accumulates, and is, as a whole, slightly more productive than the typical soil.

Table 4 shows the results of mechanical analyses of samples of the surface soil, the subsurface soil, and the subsoil of typical Weld fine sandy loam.

TABLE 4.—*Mechanical analyses of Weld fine sandy loam*

No.	Description	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
		Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
490805	Surface soil, 0 to 1½ inches	0.0	0.5	0.7	29.9	33.9	17.2	17.6
490806	Subsurface soil, 1½ to 10 inches	.0	.2	.4	28.3	30.6	17.6	22.5
490807	Subsoil, 10 to 30 inches	.0	.1	.2	16.1	34.4	28.9	20.1
490808	Subsoil, 30 to 50 inches	.0	.1	.2	17.2	39.0	24.2	19.2

WELD LOAMY FINE SAND

Associated with Weld fine sandy loam is an area of Weld loamy fine sand on the south side of Thompson River about 5 miles southeast of Loveland. This area occupies 1.6 square miles.

The soil consists of dark-brown loamy fine sand to a depth of about 12 inches, below which is light-brown loamy fine sand to a depth of 5 or more feet. The soil is believed to be of rather recent wind-blown origin. It is under cultivation and is fairly productive. Although light in texture, if overirrigated or trampled when wet it becomes cloddy on drying.

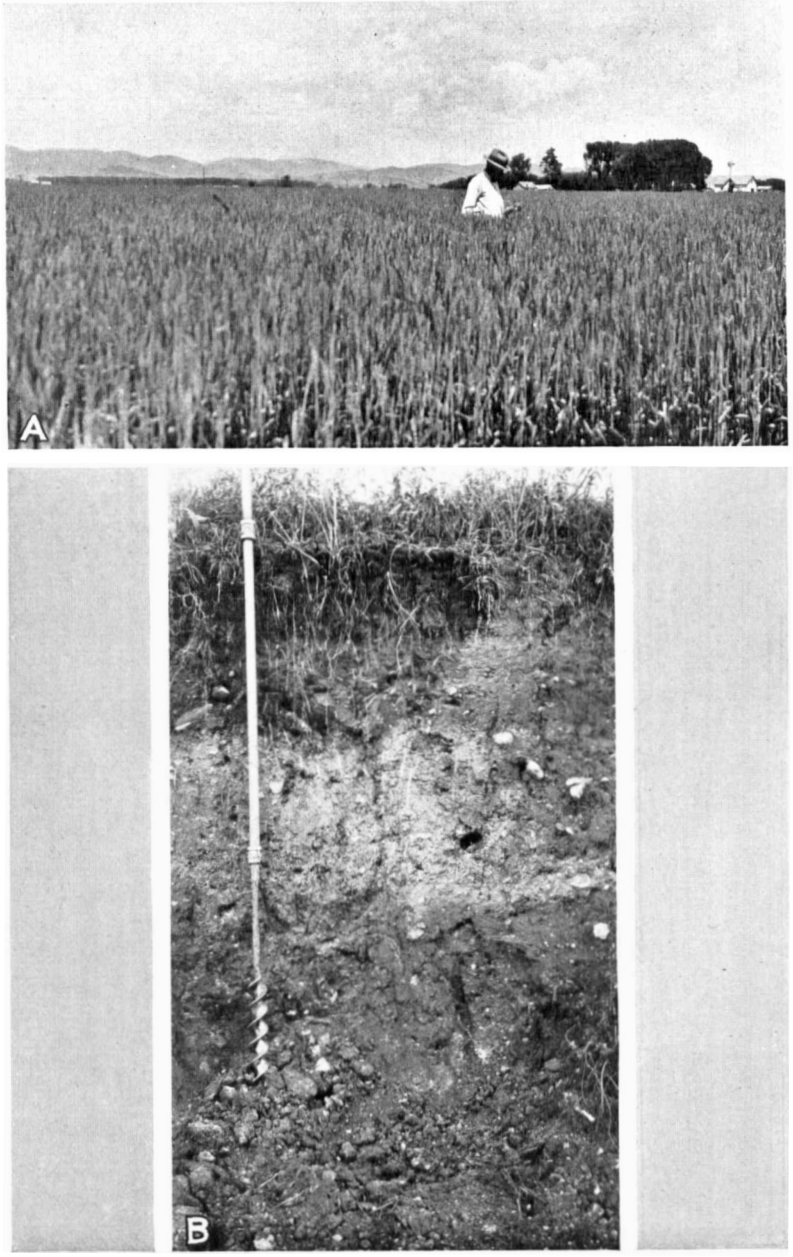
TERRY SILTY CLAY LOAM

Terry silty clay loam consists of brown or dark olive-gray heavy silty clay loam or clay to a depth of about 10 inches, below which is a somewhat lighter olive-gray soil with white spots of lime accumulation extending to an average depth of about 30 inches. It grades into partly disintegrated parent shale material of about the same color.

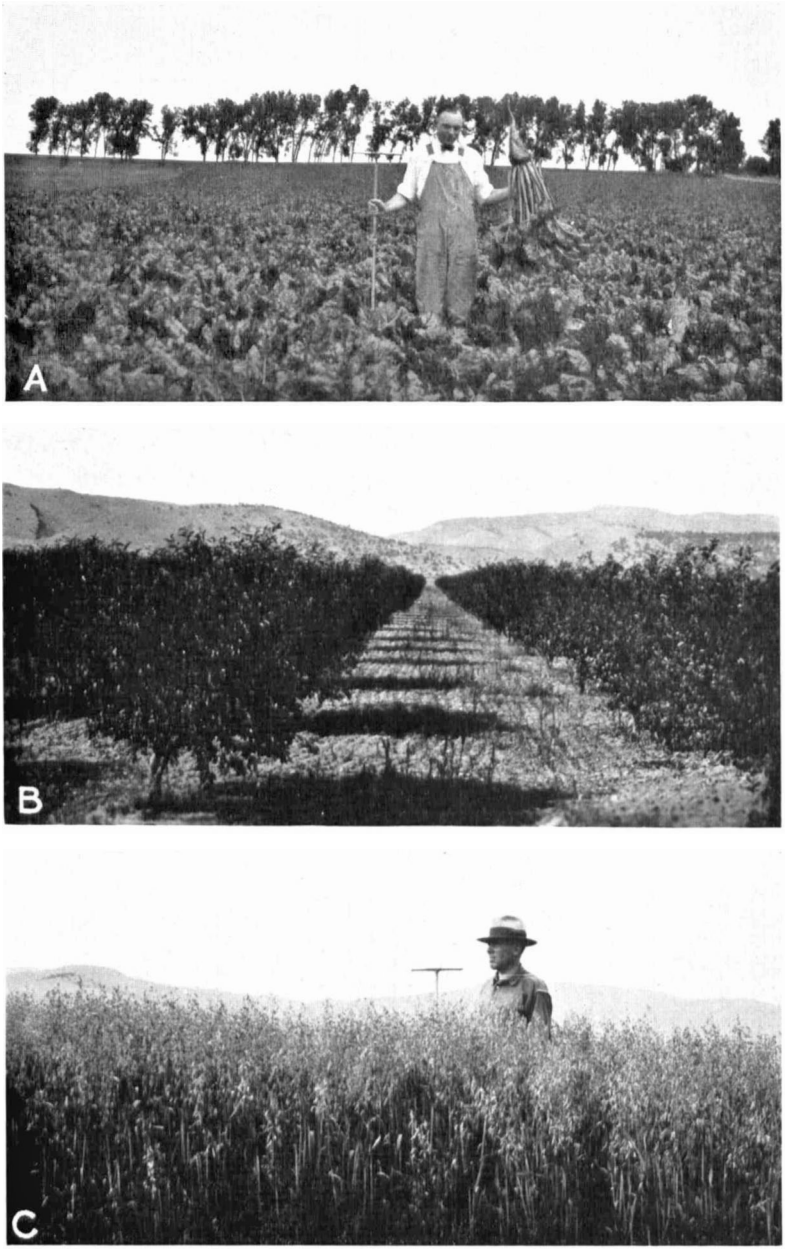
The dark surface layer when weathered for a considerable time forms a finely granular mulch, 1½ or 2 inches deep, strongly crusted at the surface which in many places is smooth and bare. Below the mulch the soil breaks into small hard angular clods. The second layer breaks into somewhat larger hard clods having a white coating along the cleavage planes and in places accumulations of alkali and gypsum.

The lines of separation between the layers are much less distinct than in the Weld soils, and it is often difficult to determine whether the lower layer of the subsoil is shale or soil material. The shale, however, generally shows a flakiness and the soil material does not.

This soil carries alkali in various amounts, and when either too wet or too dry it is very difficult to handle. It is also difficult to obtain



A, Wheat on Fort Collins loam; B, roadside cut showing the light-colored lime layer in Fort Collins fine sandy loam



A, Good crop of sugar beets on Weld loam, smooth phase; B, young cherry orchard on Terry fine sandy loam; C, oats on Neville fine sandy loam, colluvial phase

a stand of alfalfa or small grain, but when a stand is obtained the soil produces well.

Terry silty clay loam occupies a total area of 26.6 square miles. It occurs in large and small bodies principally in a belt through the western part of the area. Some of the land is under irrigation, some is dry farmed, and a considerable acreage is used for pasture land only.

Numerous small areas of this soil have, through the accumulation of drainage water, become water-logged and impregnated with alkali. Some of these have no easily accessible outlets and can not be economically drained, but others can be drained at a cost which is not prohibitive. Some drainage has been done but much more should be done. Small undrained areas are not only unprofitable but also detract from the appearance and value of the farm on which they occur.

Compared with the Weld soils with which it is associated and to which it bears a general resemblance, Terry silty clay loam is more difficult to handle, requires more water, and is less productive. It is used principally for alfalfa and small grains. Sweetclover is grown to a small extent.

Terry silty clay loam, valley phase.—The valley phase of Terry silty clay loam differs from the typical soil in being, as a whole, slightly heavier in texture, in having somewhat greater depth, in containing more alkali, and in occupying a more nearly level and less well-drained position. It occupies the lower parts of broad basinlike areas, the lower parts of small poorly defined valleys, colluvial outwash areas at the foot of slopes, and in places strips along the outer edge of the larger valleys. It supports a growth of salt grass and contains alkali in considerable quantities.

TERRY LOAM

Terry loam is dull-brown or olive-gray loam or light clay loam to a depth of about 10 inches. Below this is lighter olive-gray clay loam with well-defined light-colored spots of lime accumulation. At an average depth of about 30 inches this material grades into clay and partly decomposed shale.

The dark-colored upper layer has a thin finely granular surface mulch an inch or two deep, well crusted at the surface. Below the mulch the surface soil breaks into hard somewhat regular clods. The lighter-colored subsoil layer breaks into larger hard clods and has in places a thin coating of white salts along the cleavage planes.

This soil is not extensively developed. The principal areas are west and southwest of Campion.

This soil is used principally for dry farming. Wheat is the principal crop grown and under favorable conditions and good handling produces well, about the average for Larimer County as a whole.

Terry loam, heavy-subsoil phase.—The heavy-subsoil phase of Terry loam consists of a typical loam surface soil extending to a depth of about 12 or 15 inches, below which is a dark-brown very heavy subsoil grading at a depth of 30 or more inches into partly disintegrated shale material.

Both the typical soil and the heavy-subsoil phase have in places been modified by an accumulation of wind-blown material.

Crops and yields on this soil are similar to those on typical Terry loam.

Terry loam, valley phase.—Terry loam, valley phase, consists of dark-brown sandy loam or loam to a depth of about 12 inches, below which is slightly lighter-brown loam containing some waterworn gravel and fine micaceous sand. Below a depth of 30 inches this material grades into olive-gray sticky micaceous light loam or fine sandy loam.

Alkali is present in considerable amounts and in places forms a crust on the surface.

Soil of this phase has developed at the foot of slopes and in small valleys from wash carried down from sandy and loamy soils on the slopes. A high water table is maintained by seepage.

The land is of low agricultural value and little of it is used for cultivated crops.

TERRY FINE SANDY LOAM

Terry fine sandy loam is the brown, olive-brown, or olive-gray soil typically developed along the tops of the ridges east of Terry Lake and in like positions in other parts of the area. It consists of dark-brown or dark olive-brown fine sandy loam which grades at a depth of about 10 inches into distinctly lighter-brown heavy sandy loam or loam with well-defined white spots of lime accumulation. Where the soil is deep this layer extends to a depth of 30 or more inches, at which depth it grades into partly disintegrated sandstone which in turn grades into soft sandstone. In the western part of the area covered by this soil the parent material consists of the soft olive-gray or yellowish-green Hygiene sandstone of the Pierre formation; farther east it consists of light-brown soft fine-grained sandstone.

Terry fine sandy loam lacks uniformity, many areas on the steeper slopes being so shallow that the parent sandstone is turned up by the plow. In other places the lighter-colored subsoil is exposed by erosion, giving the fields a mottled appearance.

This soil occupies an area of 23.2 square miles, the greater part of which lies north of Cache la Poudre River. Small areas are south of Thompson and Little Thompson Rivers.

Terry fine sandy loam in the western part of the area is used extensively for growing cherries (pl. 2, B) and small fruits. That in the eastern part is used for sugar beets, alfalfa, and other crops. Some areas are used as dry farming land for wheat, beans, and other crops, but the yields are low.

Terry fine sandy loam, valley phase.—The valley phase of Terry fine sandy loam differs from the typical soil in having a darker and deeper surface layer, more level relief, and greater depth to parent material. It occupies broad nearly level and valleylike areas, where the soil has been influenced to a considerable extent by wind-blown and colluvial material. In places the water table is high and alkali has accumulated at the surface. The agricultural utility of this soil is similar to that of the typical soil. The valley phase is used largely for the production of sugar beets and alfalfa.

The results of mechanical analyses of samples of the surface soil, the subsurface soil, and the subsoil of typical Terry fine sandy loam are given in Table 5.

TABLE 5.—*Mechanical analyses of Terry fine sandy loam*

No.	Description	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
		Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
490843	Surface soil, 0 to 2 inches	0 1	0.7	1.2	42.8	22.0	17.3	14.9
490844	Subsurface soil, 2 to 12 inches	.1	.4	1.0	43.5	27.5	13.5	13.9
490845	Subsoil, 12 to 36 inches	.2	.1	.4	18.2	28.4	35.3	17.3
490846	Subsoil, 36+inches	.0	.1	.0	12.2	55.7	24.6	7.5
490846A	Sut soil, 36 to 48 inches	.0	.2	.1	12.0	56.4	25.5	6.0

TERRY LOAMY FINE SAND

Terry loamy fine sand consists of brown, dark-brown, or slightly reddish dark-brown loamy fine sand underlain, at a depth of about 12 inches, by light-brown or slightly reddish-brown heavy loamy fine sand containing a few well-defined white spots of lime and some disseminated white specks. Below a depth of 30 or 36 inches the lime spots are not present. Brown or reddish-brown soft sandstone is reached at widely varying depths. The surface soil shows a somewhat regular cleavage although the clods are very easily broken. In the second layer the somewhat regular structure is well defined and the clods are slightly harder. The third layer is of massive structure without cleavage planes.

This soil is not uniform. In places it is so shallow that the lighter-colored second layer is exposed at the surface, giving the soil a mottled appearance. It also includes areas of deep wind-blown material.

Parts of this soil are used for dry farming, but crop yields are low. It occupies an area of 3.4 square miles south of Waverly.

Terry loamy fine sand, brown phase.—On the south side of Cache la Poudre River Valley, from 3 to 5 miles south of Timnath, is an area of brown or light-brown fine sandy loam developed largely from the weathering of soft yellowish-brown sandstone associated with old clay beds. This area has been mapped as the brown phase of Terry loamy fine sand. It differs from the typical soil principally in its more yellowish-brown color, finer texture, and less well-developed soil profile. Along the steep slope bordering the valley it has been eroded, leaving the sandy and clayey material exposed at the surface. Land of this phase is used principally for grazing purposes.

LARIMER LOAM

The surface soil of Larimer loam is brown or dark-brown loam containing considerable quantities of small sharp granitic and quartz gravel over the surface and through the soil. At a depth of about 10 or 12 inches it is underlain by slightly lighter-brown heavy loam or clay loam which also contains sharp coarse sand and small gravel. Below a depth ranging from 15 to 30 or more inches is purplish-red, light reddish-brown, or gray highly micaceous limy and gravelly material characteristic of the deep subsoil underlying the Fort Collins soils. The surface soil and deep subsoil break into irregular hard clods. In a few places where seepage water has come near the surface small areas of well-developed lime hardpan occur.

This soil is rather variable in depth, in the amount of gravel which it contains, and in its value for the production of crops. In places

along the edges of the terraces on which the Fort Collins soils have developed are eroded areas which have been included with the soil in mapping.

Larimer loam occupies an area of 9.5 square miles west and southwest of Fort Collins between the areas covered by Fort Collins loam and the foothills.

A considerable part of the more easterly and deeper areas of this soil is under irrigation. The soil is used for small grains, alfalfa, apple orchards, small fruits, and a variety of other crops, and fair yields are obtained. As a whole this soil is less productive than the adjacent Fort Collins loam.

LARIMER GRAVELLY LOAM

The surface soil of Larimer gravelly loam is brown, dark-brown, or slightly reddish-brown fine sandy loam or light loam having sharp quartz, granitic, and waterworn gravel over the surface and through the soil. At a depth of 8 or 10 inches it is underlain by gray, pinkish-gray, or reddish-brown slightly heavier gravelly loam, the gravel ranging widely in kind, size, and amount, and much of it being heavily coated with lime. Below an average depth of about 30 inches are beds of very gravelly material consisting largely of waterworn gravel which are less heavily coated with lime. As shown in roadside cuts this gravelly material overlies beds of shale, a white deposit of lime marking the line of contact.

This soil covers a total of 9.3 square miles, mainly in the northern part of the area surveyed. The largest bodies are between Curtis Lake and Waverly, and other bodies are north and northeast of Wellington. A few small very gravelly areas are north and east of Timnath, on the Twin Mounds 4 miles east of Campion, and on a few other high points.

A number of areas of this soil are under cultivation and seem to produce fairly well, but as a whole the soil is of low agricultural value and is used largely as grazing land.

In a number of places gravel from the material underlying this soil has been used for road surfacing, for which it is well suited, and for ballast on the railroads. The supply seems almost inexhaustible.

LARIMER FINE SANDY LOAM

Larimer fine sandy loam has a reddish-brown or dark reddish-brown fine sandy loam surface soil with some sharp gravel on the surface and through the soil. At a depth of about 8 or 10 inches this is underlain by lighter reddish-brown fine sandy loam of heavier texture, in which a considerable amount of lime occurs in white spots and as coatings on the gravel. Below a depth of 30 inches the lime material is less abundant. The deep subsoil consists of purplish-brown or reddish-brown gravelly soil material, but the gravel is much less abundant than in the deep subsoil of Larimer gravelly loam.

This soil occupies parts of the old high outwash plain in the northern part of the area between Dry Creek and Boxelder Creek. It seems to have been modified by comparatively recent overflow and deposition of material washed from red sandstones.

Larimer fine sandy loam covers a total area of 5.7 square miles north and northwest of Waverly and northwest and northeast of

Wellington. A considerable part of the land is under cultivation, being used for alfalfa, sugar beets, small grains, and corn. Crop yields are good.

Larimer fine sandy loam, level phase.—The level phase of Larimer fine sandy loam occupies more nearly level areas, is slightly darker reddish brown in color, is heavier in texture, and has a deeper surface soil than the typical soil.

In general appearance and crop adaptation this soil rather closely resembles Fort Collins loam as developed in the valley of Thompson River near Loveland. It is a more productive soil than Larimer gravelly loam, with which it is associated.

BERTHOUD LOAM

Berthoud loam occupies the larger part of the nearly level outwash plain northwest of Lake Loveland and northwest, west, and southwest of Berthoud. It occupies a position between the foothills and the Fort Collins soils on the old terraces of Thompson and Little Thompson Rivers similar to the position of Larimer loam between the foothills and the Fort Collins soils on the old terraces of Cache la Poudre River.

This soil consists of dark-brown or very slightly reddish-brown heavy loam or clay loam to a depth of about 15 inches, below which is very light-brown or grayish-brown heavy loam or clay loam containing well-defined spots of lime. This layer is underlain at an average depth of about 30 inches by very light grayish-brown or light-gray, in places nearly white or pinkish-gray, soil material very high in lime.

Virgin areas or areas which have not been cultivated for some time have a well-developed crusted surface mulch from 1 to 2 inches thick. Below this the soil breaks into fairly hard somewhat regular clods.

In places, especially on the steeper slopes near small valleys, the surface soil contains considerable amounts of nearly white shaly limestone, and in the subsoil and deeper subsoil this material is very abundant.

Berthoud loam occupies 8.8 square miles in the Fort Collins area. A small part of the land is irrigated, a considerable part is dry farmed, and the remainder is used for grazing lands. In places it produces medium or good crops of small grain, but much of the land is of low agricultural value.

Berthoud loam, heavy phase.—Berthoud loam, heavy phase, differs from the typical soil in having a darker, heavier-textured, and deeper surface soil. The deeper subsoil contains less of the lime and shaly material.

LAPORTE LOAM

Laporte loam has a brown, light-brown, or gray loam surface soil well filled with small particles of thin nearly white shaly limestone and limy shale. At a depth of about 12 inches the surface soil grades into lighter-brown loam containing white spots of lime and a larger amount of shaly limestone fragments. At a depth ranging from 24 to 36 or more inches partly disintegrated shaly limestone is reached.

Laporte loam occurs in the southwest part of the area, mainly south of Thompson River. It includes lower foothill slopes and low narrow ridges.

This soil is used to some extent for dry farming, and in small pockets and glades where the soil is darker and deeper than typical it is used rather successfully for apple growing. Trees should not be planted, however, without first carefully examining the soil to determine which parts will allow deep rooting.

Laporte loam closely resembles the soils of the Penrose series mapped at Penrose, Colo., and is derived from similar parent material, but in the Fort Collins area the soil has weathered under somewhat less arid conditions, is darker in color, and probably contains more humus.

LAPORTE SHALY LOAM

Laporte shaly loam differs from Laporte loam in that it is somewhat lighter gray in color, shallower, and more shaly. The surface soil is well filled with sharp shale fragments and the parent shaly limestone which underlies much of the soil is reached at a depth ranging from 15 to 24 inches. This soil occupies sharp narrow ridges, steep slopes, and undulating and hilly uplands. Some of the land is used for dry farming, but yields are very low.

Areas of Laporte shaly loam occur in a narrow broken belt extending from north to south along the west side of the main body of the surveyed area. The total area of this soil is 9.6 square miles.

NEVILLE FINE SANDY LOAM

Neville fine sandy loam consists of reddish-brown, dull-red, or red fine sandy loam underlain at a depth of about 15 inches by lighter-red soil of heavier texture, which at widely varying depths grades into partly disintegrated red sandstone, or red sandstone and shale. The upper dark layer has a thin slightly crusted mulch at the surface and below this breaks into clods with somewhat regular faces. Where deep the second layer in places contains well-defined white spots of lime. Sharp sand and small gravel in varying amounts are on the surface and scattered through the surface soil and subsoil.

This soil shows rather wide variations. The parent material from which it developed includes a wide range of sandstones and shales which in places have been modified by material from limestone and from granite, quartz, and rhyolite. In depth the soil ranges from very shallow and stony on the upper parts of the slopes and around included stony areas and rock outcrops to deep, and in many places heavier, soil in the lower parts of the glades and valleys. It has been modified by colluvial material moved down the slopes, by material washed into the lower parts, and in places by an accumulation of wind-blown material.

The total area of Neville fine sandy loam is 11.4 square miles. It is used for dry farming and as pasture land. Yields on some areas range from fair to good, but considerable areas on which the soil is shallow, stony, and eroded are of low agricultural value.

Neville fine sandy loam, colluvial phase.—The colluvial phase of Neville fine sandy loam is dark reddish-brown heavy fine sandy loam or loam, underlain at a depth of about 15 inches by slightly lighter reddish-brown very micaceous heavy fine sandy loam or loam containing white spots of lime. Below a depth of 30 inches the soil is more friable, and accumulations of lime material occur in small amounts or are absent. Material of this kind in many places extends to a

depth of 5 or more feet. On the upper slopes occupied by soil of this phase partly disintegrated sandstone material is reached at various depths, generally below a depth of 36 inches.

Soil of this phase occurs on comparatively high slopes and old high terraces along the valleys of Thompson River and Buckhorn Creek. On the higher parts of these areas the soil differs little from typical Neville fine sandy loam or Neville loam, but on the lower parts it is darker in color, is deeper, and differs from soils of the Fort Collins series principally in containing a larger proportion of material from red sandstone. This soil is used rather extensively for growing apples, cherries, and small fruits, and for alfalfa, small grains (pl. 2, C), and other crops.

In Table 6 are shown the results of mechanical analyses of samples of the surface soil, the subsurface soil, and several layers of the subsoil of typical Neville fine sandy loam.

TABLE 6.—*Mechanical analyses of Neville fine sandy loam*

No.	Description	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
		Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
4908150	Surface soil, 0 to 1½ inches	2.2	5.5	4.4	20.7	28.8	21.6	10.6
4908151	Subsurface soil, 1½ to 15 inches	3.8	8.1	5.8	25.5	23.2	21.1	12.4
4908152	Subsoil, 15 to 28 inches	6.0	11.1	7.2	27.3	22.0	14.8	11.5
4908153	Subsoil, 28 to 40 inches	6.3	11.7	7.0	29.8	23.3	12.7	8.4
4908154	Subsoil, 40 to 60 inches	2.3	7.5	5.3	27.0	25.5	18.2	14.1

NEVILLE LOAM

Neville loam consists of reddish-brown or dull-red loam which, at a depth of about 15 inches, grades into slightly lighter-red heavy loam or clay loam. At widely varying depths this material is underlain by partly disintegrated red sandstone, red sandy shale, or shale. This soil has a wide range in depth and texture. In general it is very shallow and in places stony at the outer valley edge but deeper and heavier in the lower parts of the valleys. It has been modified by colluvial material, by wash, and by wind-blown material. Neville loam includes all the variations found in Neville fine sandy loam, and its separation from that soil is arbitrary. Each glade in which this soil occurs includes a number of soils, but on account of their small extent and lack of importance their separation on the soil map was not justifiable.

CASS FINE SANDY LOAM

The surface soil of Cass fine sandy loam is very dark grayish-brown, slightly reddish-brown, or purplish-brown fine or very fine sandy loam which when moist is almost black. At the surface the material is loose and friable, but it becomes slightly heavier with depth. Through it is an abundance of fine plant roots and wormholes. When dry the material breaks into large irregular clods but these are readily broken and the entire soil mass is easily pulverized. At a depth of about 15 inches the surface soil grades into very slightly lighter-brown fine sandy loam which is somewhat heavier in texture but is friable under favorable moisture conditions. The line of separation between these layers is not sharply marked as in the Fort Collins soils. Below an average depth of about 24 inches the deeper subsoil becomes lighter

brown in color, and contains indistinct spots of rust brown and gray, and the texture becomes more sandy. At widely varying depths this layer rests on sand and stream gravel. In places gravel in varying amounts is scattered on the surface, through the surface soil, and through the subsoil.

This soil varies widely from place to place. In color it ranges from deep red, where the material has been eroded largely from red sandstone, to dark brown or black, where a larger part of it has come from igneous and metamorphic rocks and from shale. The depth of the soil to the underlying stream gravel ranges from only 12 or 15 inches near the rivers or old stream channels to 5 or more feet along the edges of the valleys. Many areas of this soil are comparatively free from alkali, but other areas, especially where poorly drained, contain alkali in injurious amounts.

Cass fine sandy loam occupies low nearly level areas but much of it is not subject to overflow. Drainage of the higher-lying areas is good, but considerable areas are low lying, shallow, and, because the water table is maintained at river level, would be difficult to drain. Such places are indicated on the map by swamp symbols.

Cass fine sandy loam is the predominating soil in the valleys of Cache la Poudre, Thompson, and Little Thompson Rivers and in the valleys of some of the tributary streams. It occupies a total area of 27.5 square miles, more than half of which is intensively farmed. It is used for garden truck, sugar beets, alfalfa, corn, apples, and small fruits.

Cass fine sandy loam, red phase.—The surface soil of Cass fine sandy loam, red phase, is dark reddish-brown or dull-red fine sandy loam to a depth of about 12 inches. Where recently irrigated or subject to overflow the surface soil has a thin covering of brownish-red very fine sand carried by the irrigation water of the region. Below a depth of 12 inches the soil is lighter reddish-brown fine sandy loam of heavier texture, containing a few spots of lime and small lime-coated gravel. Below a depth ranging from 30 to 36 inches this layer grades into light-brown or light reddish-brown light fine sandy loam containing alternating layers of sand and fine gravel. In places the subsoil extends to a depth of 10 or more feet.

The red phase of Cass fine sandy loam occupies a total area of 7.5 square miles. It occurs in the vicinity of Wellington, along the channel of Boxelder Creek, and along the upper course of Dry Creek. It consists largely of material eroded from the red sandstone beds to the west and from the old high outwash plains occupied by the Larimer soils.

This soil is productive and well suited to all crops of the region but is in places cut into small areas by the stream channels. In places where drainage is poor, alkali in injurious amounts has accumulated.

Cass fine sandy loam, gray phase.—Cass fine sandy loam, gray phase, has a brown or dark-brown heavy fine sandy loam or loam surface soil extending to a depth of about 12 inches. Below this is light-brown heavy fine sandy loam or loam containing a small amount of white lime material and lime-covered gravel. This layer extends to a depth of 30 inches, below which is very light-brown or gray loam, in places containing considerable gravel.

This soil lacks uniformity of color and texture, and poorly drained areas contain alkali in considerable amounts. White incrustations

of alkali occur in places on the surface. The soil consists largely of material eroded from the light-colored shales and sandstones of the northeastern part of the area. It occupies a total of 4.3 square miles along Boxelder Creek in the northeast part of the surveyed area, principally north and east of Wellington. It is of rather low agricultural value and is used principally as grassland for pasturage.

Cass fine sandy loam, colluvial phase.—Cass fine sandy loam, colluvial phase, consists of dark-brown or slightly reddish-brown loamy fine sand grading, at a depth of 2 or 3 inches, into light fine sandy loam which extends to a depth of about 14 inches. Below this is slightly lighter-brown light-textured fine sandy loam containing a small amount of white lime material. Below a depth of 30 inches is light-brown loose loamy fine sand. Small quantities of coarse sand and small sharp gravel and some waterworn gravel are abundant on the surface and through the surface soil and subsoil.

This soil has developed from material carried into glades by wind and from colluvial material carried down the adjacent slopes. In places it occupies the outer part of old high stream terraces. It includes rather wide variations, depending on the character of the material on the adjacent slopes. Where poorly drained it has a light-red or light-brown surface soil underlain at a slight depth by white material, probably largely calcium and magnesium sulphate.

Two areas, one about 8 miles northwest of Loveland and the other northeast of the entrance to the canyon of Cache la Poudre River, have been mapped. Their combined area is 4 square miles. Soil of this phase is used for growing small grain under dry-farming conditions, and it seems fairly productive.

Cass fine sandy loam, shallow phase.—The shallow phase of Cass fine sandy loam is so shallow and gravelly that it is practically nonagricultural although it includes small areas here and there which can be utilized for gardening or for truck crops. It consists of brown or light-brown fine sandy and gravelly loam, in most places not more than 12 or 15 inches deep, underlain by sand and stream gravel. It occupies narrow strips adjacent to the present stream channels or the beds of former stream channels, principally in the valley of Cache la Poudre River. The total area covered by this soil is 2.1 square miles.

CASS CLAY LOAM

The surface soil of Cass clay loam is dark-brown or dark grayish-brown heavy clay loam well filled with plant roots and wormholes. At a depth of about 12 inches it grades into slightly lighter-brown clay loam containing white spots of lime. The line of separation between these two layers is not sharply defined as in the Fort Collins soils. Below a depth ranging from 30 to 36 inches the deeper subsoil becomes lighter grayish brown in color, lighter in texture, contains much finely divided mica, and grades into sand and waterworn stream gravel. Rust-brown and gray mottlings occur in the layer immediately above the gravel.

This soil, if overirrigated or cultivated when too wet, becomes very hard and difficult to handle on drying. It is subject to rather wide variations. On the lower or stream side of the areas it grades into Cass fine sandy loam and in the opposite direction it is modified and in places made heavier by outwash of shale material. The north side

of the area north and east of Laporte has been modified in this way. In other places, as in the area north and northeast of Fort Collins, sandy and gravelly loam carried into the Cache la Poudre River Valley by tributary streams has been deposited on or mixed with this soil. In the area along the south side of the Cache la Poudre River Valley, extending from the mouth of Dry Creek, southeast of Fort Collins, to a point about 2 miles south of Timnath, the soil is poorly drained and contains alkali in harmful amounts.

This soil covers a total of 7.4 square miles extending along one side or the other of the Cache la Poudre River Valley from Laporte to a few miles below Timnath.

The better-drained areas are used in the production of sugar beets, alfalfa, and small grains. The poorly drained areas support a growth largely of salt grass and are used as pasture lands.

Cass clay loam, colluvial phase.—Cass clay loam, colluvial phase, has a dark-brown or dark reddish-brown heavy clay loam surface soil about 12 inches deep. The subsoil is dull-brown or grayish-brown heavy sticky clay loam containing varying amounts of sharp gravel and light-colored spots of lime or gypsum. This layer, although heavy, contains considerable finely divided mica and is underlain at a depth ranging from 36 to 40 inches by light-brown very micaceous clay loam or loam, in places containing gravel in varying amounts.

This soil occurs principally in the valleys of small streams tributary to Cache la Poudre River and occupies a total area of only 1.8 square miles. Parts of the land are poorly drained. Where well drained the soil is fairly productive and is used for sugar beets, small grains, and other crops of the area.

CASS SILT LOAM, RED PHASE

Cass silt loam, red phase, consists of dark-brown or dull reddish-brown heavy silt loam underlain, at a depth of about 10 inches, by slightly lighter-brown or reddish-brown heavy silt loam containing a few small spots of white material and a small amount of sharp gravel. Below an average depth of about 36 inches is reddish-brown very gravelly sandy loam, the gravel being small and sharp and increasing in quantity with depth.

A well-developed, well-crusted granular mulch about 2 inches thick forms over areas of this soil which have been weathered for some time. The dark-colored layer below this breaks into small hard irregular clods, and the lower-lying lighter-colored layer breaks into larger hard clods. Small sharp gravel are in places rather abundant over the surface and through the surface soil and subsoil. When the soil is moist the dull-red color is much more pronounced than when it is dry. Included with this soil are a few small areas of poorly drained soil in which alkali in harmful amounts is present.

This soil consists largely of material deposited in the valley of Boxelder Creek by overflow of that stream, and apparently has been eroded from the red sandstone to the north and west and from the old high outwash plain from which soils of the Larimer series have developed. In places other soils along the western edge of the valley of Boxelder Creek have this deep red material in the subsoil at a depth ranging from 4 to 5 feet.

This soil occupies a total area of 5.2 square miles. The largest body extends as a strip about a mile wide from near the mouth of

Boxelder Creek northward about 5 miles. A small body lies southeast of Wellington and another along Dry Creek south of Waverly.

The soil is used for sugar beets, small grains, and alfalfa. The better parts of the land are highly productive.

CASS LOAM

Cass loam is brown or dark grayish-brown light loam to a depth of about 12 inches. Below this is light-gray, nearly white material, part of which is lime but part is probably calcium, magnesium, and sodium sulphate. In places white incrustations of alkali form at the surface.

This soil occupies an area of less than 1 square mile southeast of Timnath. It supports a growth of wild grasses, principally salt grass, and is used for grazing purposes.

ROUGH MOUNTAINOUS LAND

The Fort Collins area includes strips of mountain slopes on its borders, and a number of hills and ridges within the main body of smoother land. The term rough mountainous land has been applied to these areas of rough land, where the soil is not tillable either on account of the steepness of the slopes or because of the large amount of rock strewn over the surface or embedded in the soil. The slopes in many places rise abruptly from the smooth flat areas to mountainous peaks and ridges with a gradient of 1,000 or more feet to the mile. Bare rocky slopes and rock ledges and cliffs are common. In all the rough mountainous land areas the soil covering, if any has formed, is very shallow, supporting only a scant growth of grass and in places small hardy shrubs which provide some pasture for livestock, but aside from this the land has no agricultural value.

SOILS AND THEIR INTERPRETATION

The main body of the Fort Collins area is in the extreme western part of the Great Plains region, a small part of it lying between chains of foothills along the eastern slope of the Rocky Mountains. It is situated between parallels of 40° and 41° north latitude. It has an elevation above sea level of approximately 5,000 feet. The annual precipitation is nearly 15 inches, 40 per cent of which occurs during the spring months and more than 30 per cent during the summer. A considerable part of the precipitation during winter and early spring is in the form of snow, the average annual snowfall being 42.8 inches. The vegetation is an association of the short grasses (buffalo and grama) which occupy the region to the east, and the bunch grass which is dominant in the valleys to the west. Humidity is low, being only 53 per cent saturation as compared with 69 per cent at Omaha and 78 per cent at San Francisco. The average velocity of winds is slightly lower than in the southeastern part of the State, being 7.4 miles an hour at Denver.

All of these conditions are factors which influence soil formation and development. The result, as expressed in completely developed soils, has been soils with the following characteristics: (1) A dark-colored upper layer extending to a depth of about 12 inches; (2) a lighter-colored slightly heavier layer containing white spots, largely

of lime accumulation, which extends to a depth ranging from 30 to 36 inches below the surface; and (3) a layer much the same in color as the layer above but slightly lighter in texture and nearly free of lime spots.

The upper part of the first layer is a finely granular mulch from 1 to 2 inches deep which is slightly crusted at the surface, being thicker and more firmly crusted in the heavier soils than in the light-textured soils. Below the mulch both the dark-colored upper layer and the lighter-colored heavier layer show a fairly well-defined somewhat cubical structure on drying. The third layer has a poorly defined columnar structure.

The transition between the first and second layers is abrupt and sharply marked, but that between the second and third layers is not so clearly defined.

The second layer shows a slightly higher soluble salt content, as indicated by the electrolytic bridge, than the layers either above or below it. This, however, is much below the toxic limit for sodium or magnesium sulphates, the predominating salts of this region.

In a number of places in the Fort Collins area completely developed soils of this kind overlie other older soils. In these older soils the upper layer has lost its original color but the second layer shows a very high concentration of lime, indicated by a thick white layer from 8 to 10 feet below the surface of the more recent soils. Buried soils of this kind occur in the alluvial material of old high nearly level stream terraces, under the Fort Collins soils, and in the wind-blown or loessial material, on more or less uneven uplands, under soils of the Weld series.

Differences between the soils of the Fort Collins series and those of the Weld series are due to differences in the character of the parent materials and differences in relief. The Fort Collins soils are developed from a mixture of soil materials eroded from igneous and metamorphic rocks, red sandstones, and clay shales. The Weld soils are largely from material blown from the clay shales, with some material from closely related sandstones and from the river flood plains.

Variations within soils of the Fort Collins series are owing largely to differences in materials carried by the streams which deposited them, those deposited by Cache la Poudre River being largely from igneous and metamorphic rocks and those deposited by the other streams containing a larger proportion of material from red sandstones.

Soils of the Weld series vary slightly according to the kind of parent material and its assortment by the wind and also according to relief, being more uniformly developed on nearly level areas like those east of Campion than on uneven areas like those northwest of Plummer.

Soils of the Berthoud series, although developed on nearly level areas, do not as a rule have very completely developed profiles, the parent gravelly outwash material being reached in the deeper part of the subsoil.

These soils have the dark surface layer with the thin-crusted mulch and the lighter-colored heavier subsoil layer with accumulations of lime, especially as a coating on the gravel, but the second layer grades into a poorly defined third layer. The line of demarcation between the first and second layers is not sharp as in soils of the Fort Collins and Weld series. The Larimer and Berthoud soils differ from each other

in character of parent material, the Larimer soils being largely from outwash material containing large amounts of intermountain material and red sandstone material and the Berthoud soils largely from outwash from clay shales and soft shaly limestones. They also differ in stage of development, the Larimer soils being much older and having the three layers more completely developed.

Soils of the Terry, Neville, and Laporte series are all shallow incompletely developed soils which have inherited their main characteristics from the parent material. The Terry soils have an olive-brown or olive-gray color characteristic of the clay shales and Hygiene sandstones of the Pierre formation from which they have developed. Parent material is reached at a depth ranging from only a few inches to more than 3 feet. Soils of the Neville series owe their red color and sandy texture to the red sandstone and shales of the Fountain, Lyons, and Lykins formations. Soils of the Laporte series have developed from slight weathering of the light-gray shaly limestone of the Niobrara formations.

Soils of the Cass series consist of slightly weathered soil material from widely varying sources. In the upper parts of the main stream valleys the proportion of material carried from high areas in the mountains is large. Farther downstream material from sandstones, shale, and outwash material is added. Below the mouth of Boxelder Creek considerable sharp and some waterworn gravel from the high outwash plains is carried into the valley of Cache la Poudre River and strongly modifies this soil. The red phases of the Cass soils owe their color to material from the red sandstone, and the gray phase to wash from gray shale and sandstone.

SUMMARY

The Fort Collins area covers 454 square miles at the western edge of the Great Plains in northern Colorado. The land, which is fairly smooth and eastward sloping, has been dissected by three small rivers, each bordered by a wide flood plain and wider old flood plains or terraces. Small valleys between chains of adjacent foothills have been included.

The normal annual rainfall is slightly less than 15 inches, and the length of the frost-free season is 142 days. The air is clear, cool, and invigorating. Plants grow rapidly and mature quickly. Small grains and sugar beets yield well. The area is well supplied with water for irrigation. Markets and transportation facilities are good.

Considering the soils as a whole the Fort Collins series includes the largest proportion of highly productive soils, the Weld series the next largest, and the Cass series the third. Considerable areas of other soils, however, are highly productive.

The important crops are sugar beets, alfalfa, and small grains; the less important crops are corn, truck and garden products, small fruits, and orchard products. Dairying and the raising and feeding of cattle and sheep are important industries.

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[PUBLIC RESOLUTION No. 9]

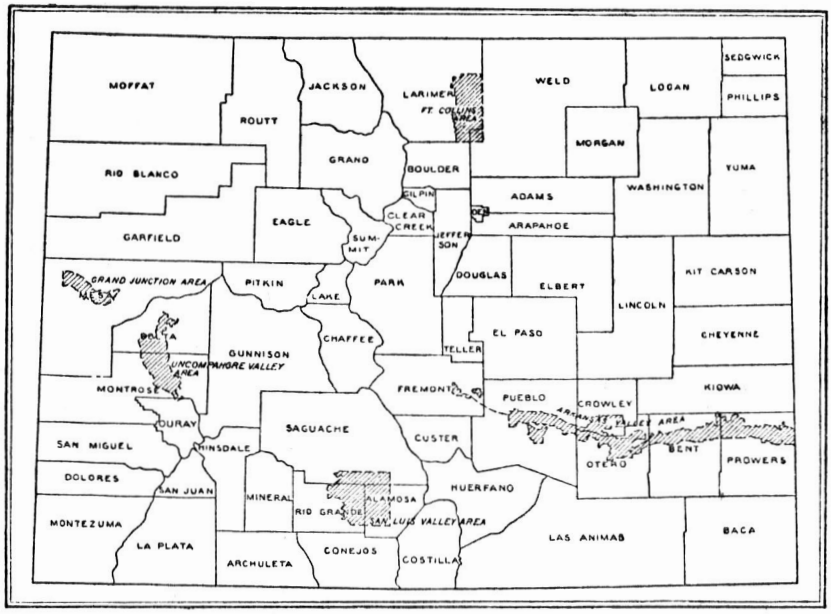
JOINT RESOLUTION Amending public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, "providing for the printing annually of the report on field operations of the Division of Soils, Department of Agriculture"

Resolved by the Senate and House of Representatives of the United States of America in Congress assembled, That public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, be amended by striking out all after the resolving clause and inserting in lieu thereof the following:

That there shall be printed ten thousand five hundred copies of the report on field operations of the Division of Soils, Department of Agriculture, of which one thousand five hundred copies shall be for the use of the Senate, three thousand copies for the use of the House of Representatives, and six thousand copies for the use of the Department of Agriculture: *Provided*, That in addition to the number of copies above provided for there shall be printed, as soon as the manuscript can be prepared, with the necessary maps and illustrations to accompany it, a report on each area surveyed, in the form of advance sheets, bound in paper covers, of which five hundred copies shall be for the use of each Senator from the State, two thousand copies for the use of each Representative for the congressional district or districts in which the survey is made, and one thousand copies for the use of the Department of Agriculture.

Approved, March 14, 1904.

[On July 1, 1901, the Division of Soils was reorganized as the Bureau of Soils, and on July 1, 1927, the Bureau of Soils became a unit of the Bureau of Chemistry and Soils.]



Areas surveyed in Colorado, shown by shading

U. S. GOVERNMENT PRINTING OFFICE: 1931

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CURTIS F. MARBUT, IN CHARGE SOIL SURVEY

SOIL MAP
FORT COLLINS AREA
COLORADO

COLORADO AGRICULTURAL EXPERIMENT STATION
C. P. GILLETTE, DIRECTOR

Soils surveyed by A. T. Sweet, U. S. Department of Agriculture, in charge, and J. N. Spencer, Colorado Agricultural Experiment Station.

Scale $\frac{1}{62500}$

Contour interval 20 feet.
Datum is mean sea level.

Field Operations
Bureau of Chemistry and Soils
1927